Timothy M. Kiefer, William C. Dawn, Khaldoon Al-Dawood, Scott Palmtag

North Carolina State University

International Conference on Physics of Reactors 2022

Control Rod Modeling in Liquid Metal-Cooled Fast Reactors

Control rod modeling in Liquid Metal-cooled Fast Reactors (LMFRs) is important for an accurate simulation, especially in depletion calculations. Recently, control rod search and cusping models have been added to the LUPINE multiphysics fast reactor simulator. LUPINE stands for the "LMFR Utility for Physics Informed Nuclear Engineering," and is currently being developed at North Carolina State University. LUPINE models the coupled multiphysics effects in LMFRs, including neutronics, thermal hydraulics, thermal expansion, and depletion. The control rod search has been implemented using a Newton-secant search in an inexact-Newton iteration and the cusping model uses a polynomial technique to correct for control rod cusping. The control rod cusping and search models were demonstrated by modeling the Advanced Burner Reactor MET-1000 Sodium-cooled Fast Reactor (SFR) and a long-life Lead-cooled Fast Reactor (LFR) based on a Westinghouse Electric Company design. A differential control rod worth curve was calculated for both reactor models to demonstrate the control rod cusping model. The SFR and LFR models were used to demonstrate the importance of modeling control rod movement during depletion calculations and the adverse effect of control rods on cycle length is demonstrated.